

Synthetic inertia provision by fast responsive reversible hydrogen production processes

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Highlights

- Need for synthetic inertia with increasing RES penetration.
- Potential in electrolysis processes and fuel cells.
- Large overall potential in DSM for provision of ancillary services.

1. Introduction

One of the effects of integrating more RES in the electricity grid is the loss of system inertia. Classical thermal power plants have large rotors, all spinning at speeds so to generate power at 50 Hz, hence the term synchronous generators. The total mass of these rotors inherently created a large system inertia, limiting the Rate of Change of Frequency (RoCoF) in case of a disturbance. The RoCoF is a measure for the robustness of the electrical grid and needs to be maintained within certain limits for safe operation.

2. Inertia in the electricity grid

ENTSO-E, the European Network of Transmission System Operators for Electricity, has launched a guidance document for the implementation of Synthetic Inertia (SI) for countries that already see large penetration of RES in their network [1]. ENTSO-E defines SI as a facility provided by a power park or HVDC system to replace the effect of inertia by synchronous generators. While able to be provided by wind or solar power parks [2], also on the demand side possibilities are identified. Already in 2015 a private company made news with the possibility of providing SI with an electrolysis process. The respective system was able to respond within 800 ms and 140 ms for the “turn on” and “turn off” respectively [3]. Indeed, also in the doctoral dissertation of Rezkalla M., Demand Side Management is identified as one of the suitable technologies for inertia support. It is also stated that the capacity of DSM has been underestimated due to the complexity considering monitoring and aggregation [4]. With recent advances on both levels, DSM could withhold a large potential in providing ancillary services, including SI.

While in some EU countries regulation regarding frequency response from large RES power parks are already in place, no real market for inertial frequency response is set-up. This with the exception of Ireland where with the DS3 program system services like synchronous inertial response and fast frequency response are contracted with market parties [5].

3. Link to chemical industry

Building an electrolyser for the sole purpose of supporting the grid by supplying synthetic inertia or Frequency Containment Reserves (FCR) might not be economically viable. For that reason it should be looked at from a different viewpoint. Let's take hydrogen as an example. The large majority of the used hydrogen in chemical industry today is produced by Steam Methane Reforming (SMR) with natural gas, releasing large amounts of CO₂. A hydrogen demanding process could be fed with own – electrolyser produced – hydrogen. Combining intermediate hydrogen or methanol storage with a hydrogen or methanol fuel cell creates ideal storage potential, with the possibility of feeding electricity back into the electricity grid. With respect to the storage, methanol is to prefer over hydrogen for large scale and longer term storage. Drawbacks of hydrogen storage are the diffusivity, high pressures and lower caloric value compared to methanol. Methanol synthesis can be done with CO₂ captured from an own – preferably high CO₂ concentration - process stream, reducing the direct CO₂ emissions.

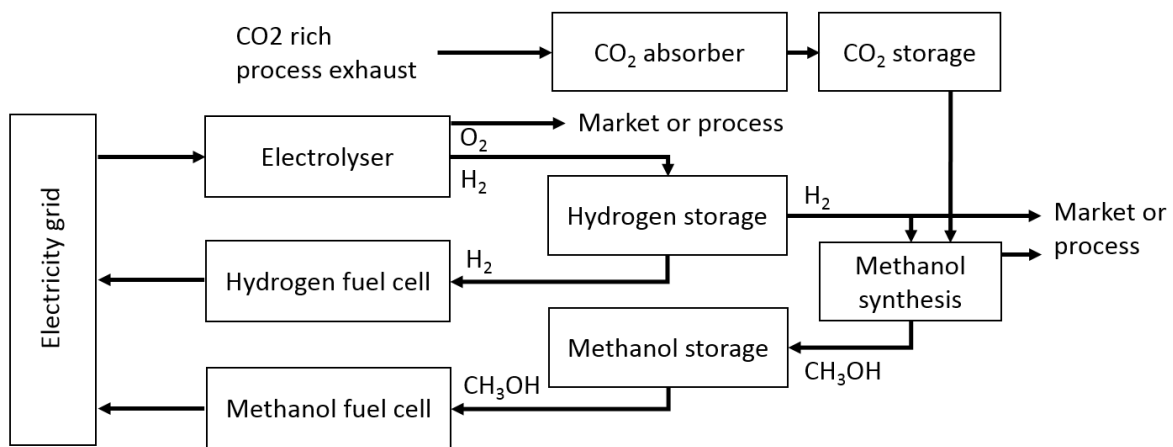


Figure 1: Flow diagram of reversible hydrogen production installation

4. Conclusion

With the increasing penetration of RES in the synchronous grid, caution should be taken to maintain the systems inertia, limiting the ROCOF. In chemical industry, potential is present in the form of electrolysers and fuel cells, which can be controlled to deliver synthetic inertia. The economics of SI provided by dedicated electrolysers might not be viable. Therefore integrated systems could be implemented, in which the provision of SI and ancillary services in general can create extra revenue.

References [Calibri 10]

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